MODIS DATA STUDY
TEAM PRESENTATION

January 5, 1990

AGENDA

1. MODIS Instrument History Data Products (McKay)
2. Optimization Considerations for a MODIS-T Tilt Strategy (Ardanuy)
3. Across-Scan Distribution of Sun Glitter (Gregg)
4. MODIS Processing, Storage, and Communications Requirements Study Plan (Ardanuy)
5. MODIS Deliverables Inventory (Preliminary) (Ardanuy)

MODIS Instrument History Data Products

Preliminary Comments from Dr. Bruce Guenther and Dr. John Barker.

On Thursday morning, Jan. 4, several members of the MODIS Data Team met with Dr. Bruce Guenther (Code 673) and Dr. John Barker (Code 625) to discuss data product requirements for MODIS instrument data. As part of an earlier effort to define Level-1 processing, three data products that result from Level-1 processing had been defined; these are the Level-1 Science Data, an "Instrument Response History", and an Instrument Characterization Team (ICT) Support Product. The purpose of the meeting was to further develop requirements for an "Instrument Response History" and to receive further inputs from scientists involved on the general need for a historical record of MODIS instrument activities and events.

To provide a context for decisions affecting the nature of this product, data retention needs for all types of MODIS instrument data were discussed. It was generally felt that the instrument information needs of the routine MODIS data users are minimal and can be adequately served by the instrument information routinely included with the distributed products. A separate instrument history product would be directed primarily toward users with special interests and qualifications that equip them to deal with the complexities of a functioning (or not-functioning) MODIS instrument. The envisioned users of this product include members of the MODIS Instrument Characterization Team (ICT), perhaps the original designers of the MODIS instrument and designers of future instruments, and possibly members of the general scientific and technological community with a specific interest in the MODIS or similar instruments. Complexity notwithstanding, every effort should be made to provide a "user friendly" product readily accessible and comprehensible to the interested general user.

The potential sources of MODIS instrument data include instrument command and monitoring resources (including the Instrument Command Center [ICC]), near-real-time data analysis facilities, and ground processing and analysis facilities. The near-real-time data analysis facility is a new architectural element in the data system that provides quick-response monitoring of MODIS operations from a scientist's perspective. The proposed name for the facility is the MODIS Characterization System (MCS); it will provide a variety of scientific analyses relating to the quality of MODIS observations and will include all post-launch calibration analyses as well as monitoring of basic radiance as measured by the MODIS instruments and quality monitoring for specific derived geophysical products.

Although the MCS will monitor MODIS instrument behavior and provide occasional quality assessments for scientific products, data generated in the MCS will not be retained in the instrument history archives. All routinely-applied and permanently-retained data quality assessments will be performed in facilities designated for routine processing and data storage. The MCS is a facility for experimental data checks and analyses and will likely contribute data quality verification routines suitable for routine application to MODIS data. It will not serve as the primary facility for the routine application of these data quality tests.

MODIS INSTRUMENT HISTORY PRODUCT

I. Purpose of product (What is the purpose of the product?)

[Summarize relevant EosDIS and MODIS Level-I and -II requirements and provide integrated, high-level description of product functions.]

II. Users of product (Who are the potential users of instrument data?)

A. Science data users

B. Instrument managers and controllers

C. Instrument performance analysts

1. Instrument Characterization Team (ICT) members

2. Past and future instrument designers

3. Interested members of the general scientific and technological community

III. Available instrument data (What MODIS instrument data is available?)

A. Instrument planning and control data

1. Observation requirements

2. Observation strategy and impact (conflict resolution) analyses

3. Intended instrument maneuvers

4. Command uploads

B. Instrument response data

1. Downlinked instrument engineering data

2. Instrument maneuver history

3. Instrument performance analyses (including calibration analyses)

4. Recommended geometric, spectral, and radiometric calibration constants and data interpretation procedures

5. Summary of instrument activities and performance

C. Anomaly reports

1. Unanticipated instrument behavior

2. Data processing irregularities and failures

IV. Proposed specific content of product

OPTIMIZATION CONSIDERATIONS FOR A MODIS-T TILT STRATEGY

1. Minimize the sun-glint contamination in the observations

A major source of contamination to the water-leaving radiance signal is the specular reflection from the Sun, termed sun glint. The anisotropic distribution of the sun glint radiances is geometry dependent, and is also a function of the surface wind speed and, secondarily, the stability of the atmospheric boundary layer. The sun glint may be minimized for a particular region by viewing the target in zenith and relative azimuth angles as far as possible away from the specular point.

2. Minimize the satellite zenith angle for high solar zenith angles

Contamination to the water-leaving radiances due to atmospheric scattering and attenuation is reduced through the application of atmospheric corrections. Uncertainties in the concentration and distribution of atmospheric constituents and the removal of their respective optical effects is amplified with increased atmospheric paths. At high solar zenith angles, it is important to provide as small a path as possible (as near a vertical zenith angle as possible) for the ocean to spacecraft leg of the radiance.

3. Minimize the data loss due to intra-orbital changes in the tilt

Changes in the tilt of the MODIS-T instrument from fore to aft will result in overlapping data. However, changes in the tilt of MODIS-T from aft to fore will result in, effectively, groups of missing scan lines. On the order of 600 km of along-track data (5° of angle along the orbit) could be lost if an instantaneous shift from 20° aft to 20° forward was made in the tilt angle. Added to this is the effect of the 7 km/sec motion of the sub-satellite point. Such data gaps are undesirable and should be avoided where possible. Any MODIS-T data coverage gaps could be filled in through the use of MODIS-N observations providing that these data are not contaminated by sun glint.

4. Maximize the coverage of a joint MODIS-T and MODIS-N global ocean color product

The generation of ocean color and biological data products from solely MODIS-T or MODIS-N data will result in systematic data losses due to the existence of uncorrectable regions of pronounced sun-glint contamination. These data gaps will be latitudinally dependent and will migrate slowly in response to changes in the solar declination. The missing data will be located primarily on the sunward (towards local morning) half of the scan. The pattern of missing data will repeat for each orbit, subject to modulation by the wind speed. Of course, at these low latitudes, overlap between adjacent orbits will not occur. The choice of a MODIS-T tilting strategy that avoids sun-glint contamination where MODIS-N data is contaminated will result in the ability to create a global product with substantially more spatial coverage in the tropics and subtropics.

MODIS Across-Track Glitter Radiance Distribution

Sun glitter may be an important component of the retrieved radiance detected by MODIS, and as such must be corrected in order to obtain accurate water-leaving radiances. The distribution and amount of sun glitter is directly related to wind speed. Our goal is to evaluate the dependence of wind speed on sun glitter in an effort to determine what accuracy of wind speed determinations are required for MODIS.

As a first step in this analysis, we determined the distribution of sun glitter under several wind speeds for realistic Eos orbital geometries. Sun glitter depends not only on wind speed but also on orbital geometry. Thus a simulation of Eos orbits provided a realistic assessment of solar and spacecraft orbital geometries and the amounts of sun glitter as a function of wind speed.

Sun glitter was estimated as a function of wind speed using the theory of Cox and Munk (1954) as presented in Viollier, et al. (1980). All simulations were performed for a sub-satellite Earth location at the Equator, with the sun at the vernal equinox. This location is one in which a substantial amount of sun glitter contamination may be expected.

Figures 1 through 6 show glitter radiances at 500 nm across MODIS scan track as a function of several wind speeds. Also depicted is the error resulting from over- and underestimating wind speed, which, it may be noted, can be considerable.

Preliminary investigations suggest that a radiance error of 0.02 mW cm^{-2} μm^{-1} sr^{-1} at 500 nm is required to maintain MODIS NEdL requirements for all visible wavelengths. However, this error level is dependent upon chlorophyll concentration and aerosol type.

These simulations provide a realistic platform from which to estimate the wind speed requirements for MODIS. These investigations are ongoing and will be presented in the near future.

References

Cox, C. and W. Munk, 1954. Measurement of the roughness of the sea surface from photographs of the sun's glitter. J. Mar. Res. 44: 838-850.

Viollier, M., D. Tanre, and P.Y. Deschamps, 1980. An algorithm for remote sensing of water color from space. Boundary-Layer Meteorology 18: 247-267.

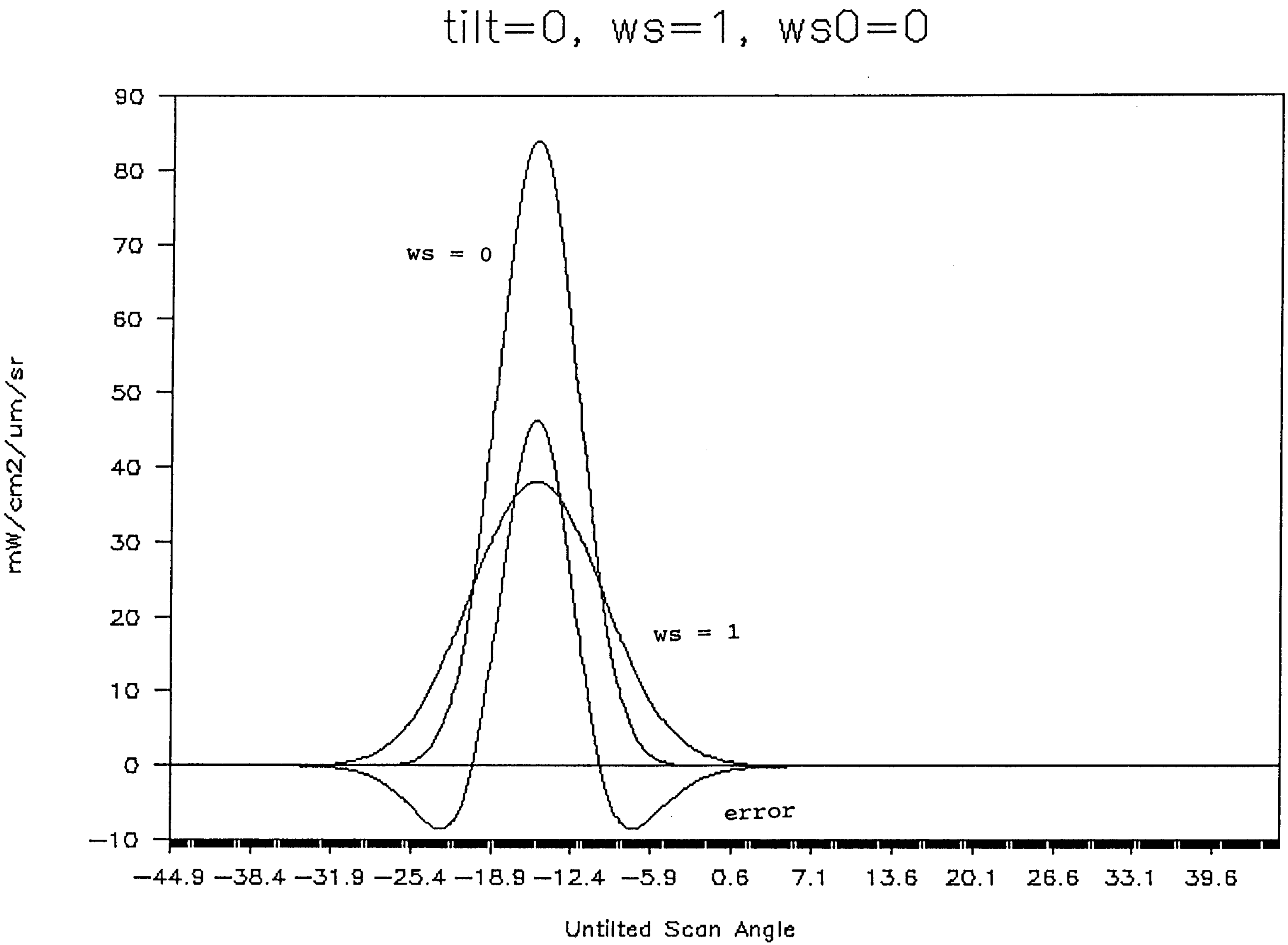

Figure 1. Glitter radiance at 500 nm for 0 tilt, assuming wind speed of 0 m s^{-1} when the true wind speed is 1 m s^{-1}.

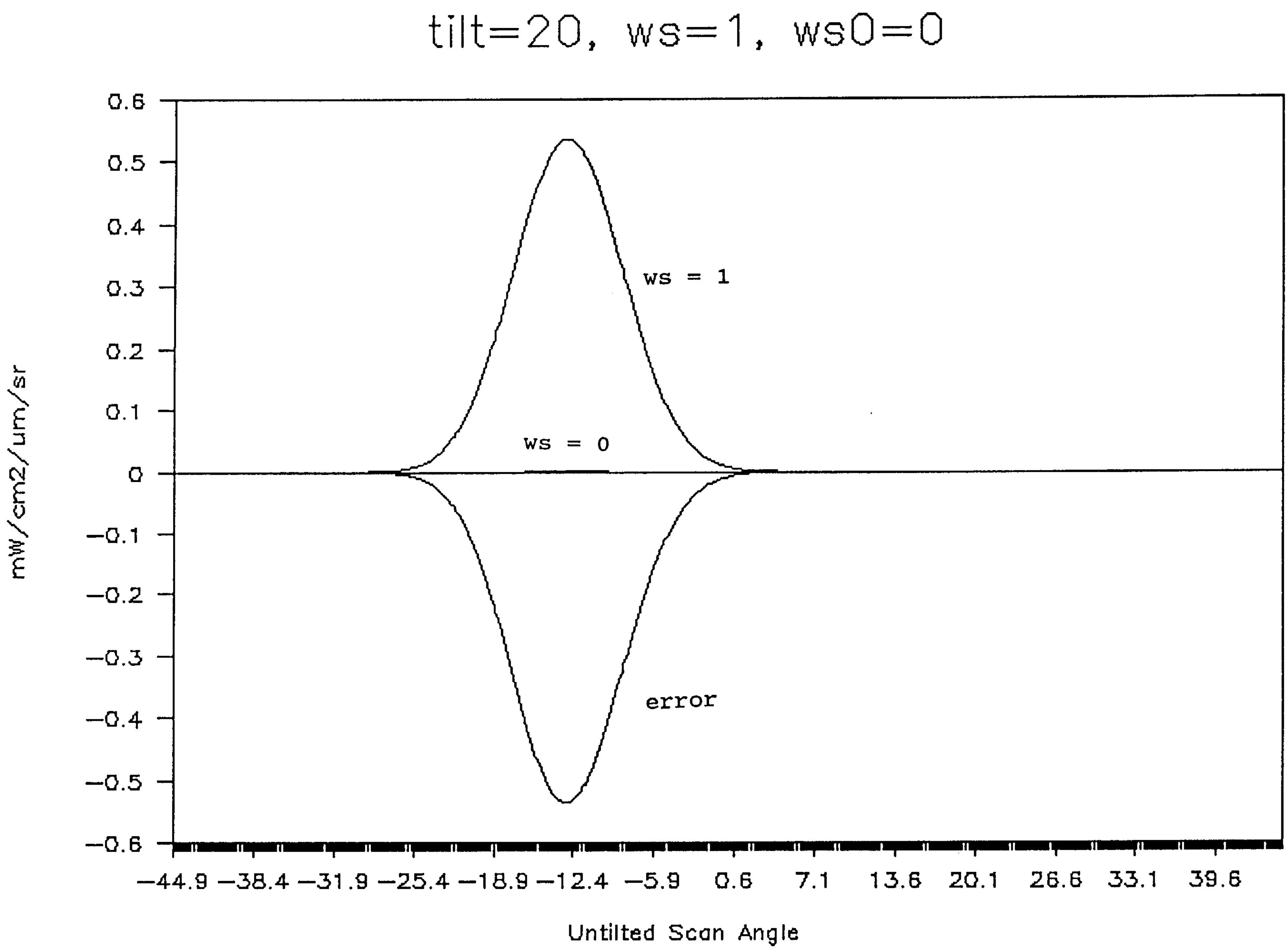

Figure 2. Glitter radiance at 500 nm for 20° tilt, assuming wind speed of 0 m s^{-1} when the true wind speed is 1 m s^{-1}.

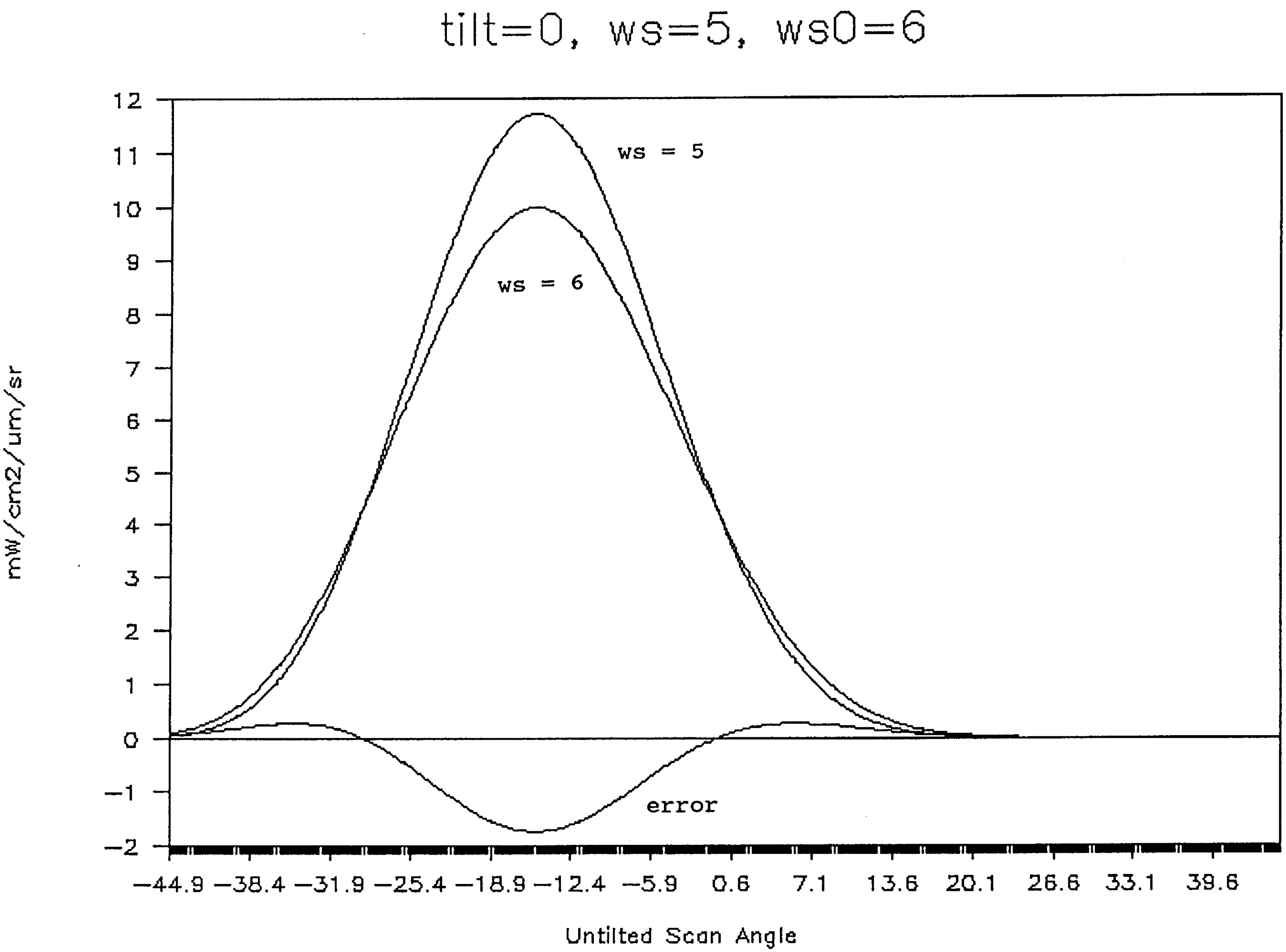

Figure 3. Glitter radiance at 500 nm for 0 tilt, assuming wind speed of 5 m s^{-1} when the true wind speed is 6 m s^{-1}.

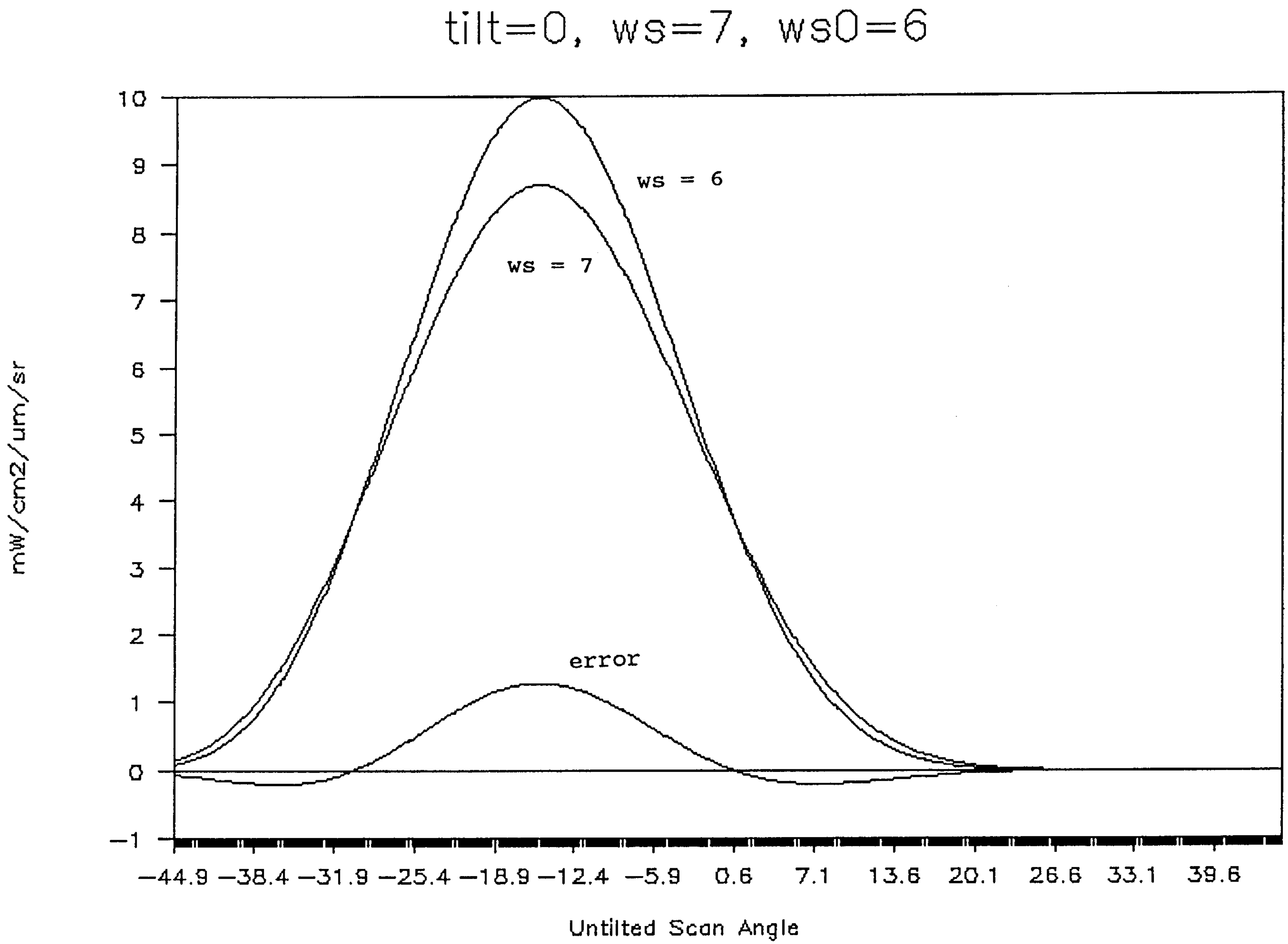

Figure 4. Glitter radiance at 500 nm for 0 tilt, assuming wind speed of 7 m s^{-1} when the true wind speed is 6 m s^{-1}.

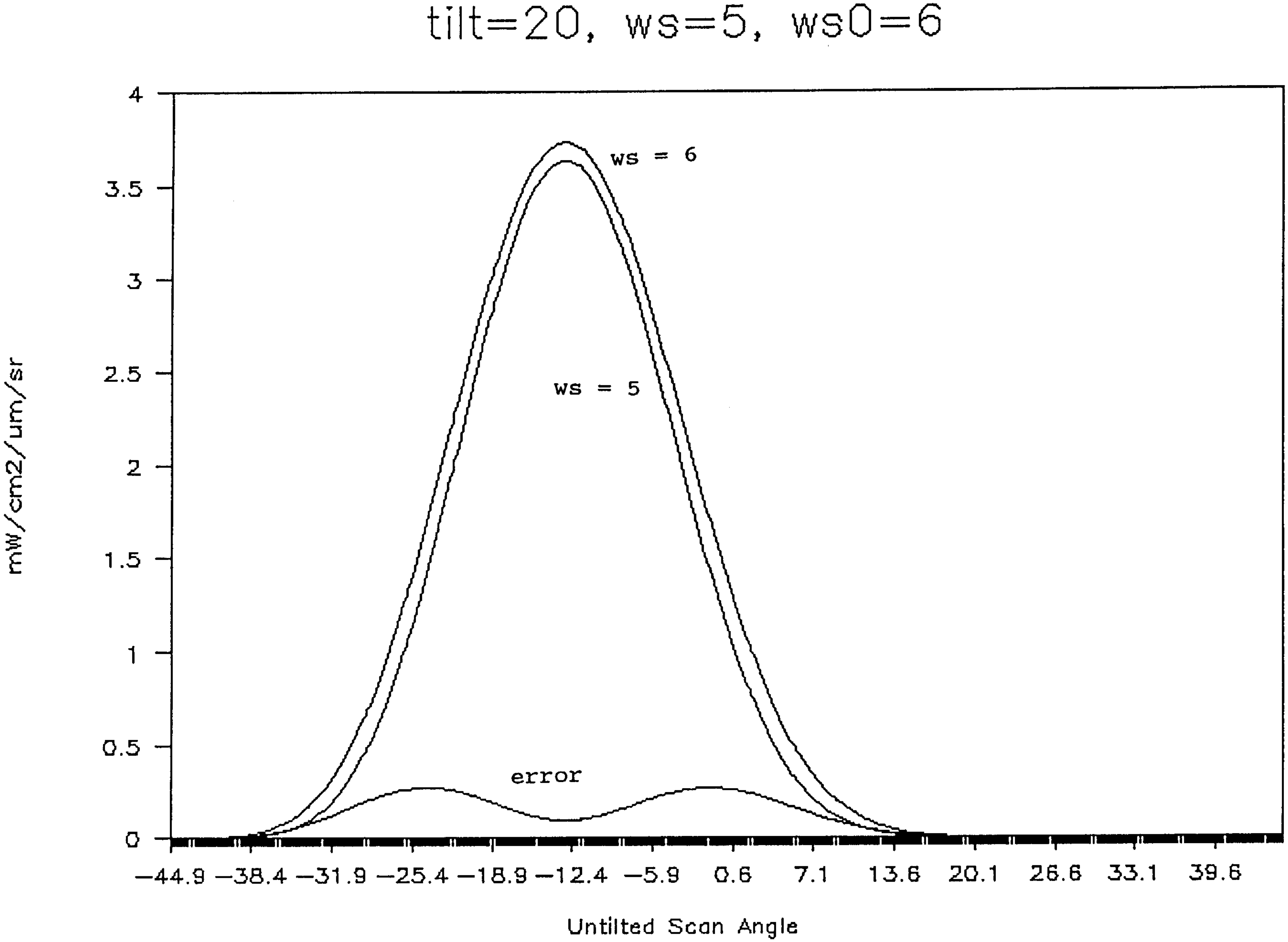

Figure 5. Glitter radiance at 500 nm for 20° tilt, assuming wind speed of 5 m s^{-1} when the true wind speed is 6 m s^{-1}.

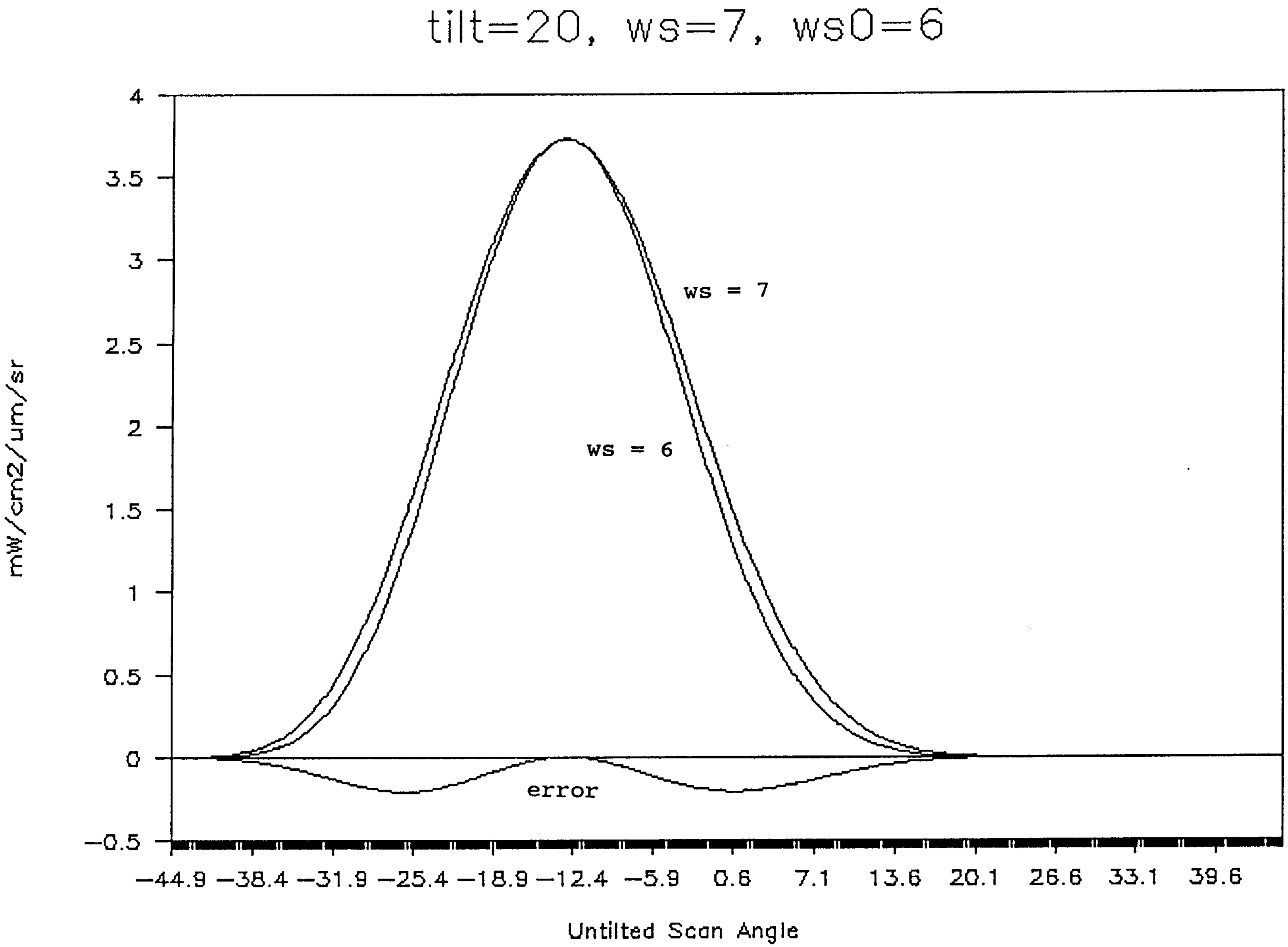

Figure 6. Glitter radiance at 500 nm for 20° tilt, assuming wind speed of 7 m s^{-1} when the true wind speed is 6 m s^{-1}.

MODIS Processing, Storage, and Communications Requirements
Study Plan

- Deliverable due February 28, 1990

- Objectives of Deliverable:

1. Estimation of the CPU and storage requirements for MODIS core data product generation, to a factor of two if possible.

2. Estimation of the communications capacities required to support the generation, validation, archival, and distribution of the MODIS core data products.

3. Development of a flexible analysis tool to support evolutions in the MODIS data processing operations concept and model impacts of proposed revisions to the MODIS performance requirements.

ANALYSIS RESPONSIBILITIES	
LEVEL-1 PROCESSING	
Calibration	Doug
Navigation	Al/Doug/Phil/Tom
LEVEL-2/3/4 PROCESSING	
Processing Control	Al/Mike/Phil/Tom
Ocean Discipline	Tom/Watson
• Atmospheric Correction	
• Product Generation	
• Time and Space Averaging	
Terrestrial Discipline	George/Jacobus
• Atmospheric Correction	
• Product Generation	
• Time and Space Averaging	
Atmospheric Discipline	Doug/Mike
• Product Generation	
• Time and Space Averaging	
GENERAL	
Integration of Estimates	Phil
Browse and Metadata	Al/Tom
Reprocessing	
Future Growth	

MODIS DELIVERABLES INVENTORY
December 26, 1989

Title	Date	Disposition
Utility and Support Algorithm Requirements	December 1989	Under Review
Post-Launch Data Processing Scenario	December 1989	Under Review
Core Data Product Processing Scenarios	November 1989	Under Review
Core Data Product and Algorithm Report	November 1989	Under Review
Science and Data System Requirements (IEEE)	November 1989	Delivered
Data Packetization Recommendations	September 1989	Delivered
ASPRS Presentation	April 1989	Delivered
Data Requirements Document	April 1989	Delivered
Interface Comparison Document	April 1989	Delivered
Data System Study Presentation to the Science Team	March 1989	Delivered
EosDIS Architecture Review	April 1988	Delivered
MIDACS System Performance Requirements MIDACS External Interface Document MIDACS CDHF Operations Concept (Incl. Levels 2/3/4 Data Proc. Ops. Conc.) MIDACS Preliminary Operational Concept	August 1988	Delivered
MIDACS Calibration Data Products Plan	September 1988	Delivered
MODIS-HIRIS Ground Data Systems Commonality Report	December 1988	NASA TM 100718
MIDACS Level-II Functional Requirements	December 1988	NASA TM 100719
MIDACS Operations Concept	December 1988	NASA TM 100720
MIDACS Specifications and Conceptual Design	December 1988	NASA TM 100721
HIRIS/MODIS Ground Data Systems: Functional Requirements, Level-I	December 1988	GSFC DOC D-8802